OCCURRENCE OF SHRUBS ON RANGE AREAS

IN

SOUTHEASTERN ARIZONA

A Condensed Report
of
The Results of a Co-operative Survey
by the
Arizona Agricultural Experiment Station
Southwestern Forest and Range Experiment Station
Agricultural Adjustment Administration
Bureau of Agricultural Economics

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Issued by the Arizona Agricultural Experiment Station
March 1937

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INTRODUCTION

The constantly increasing amounts of shrubs of little or no palatability to domestic livestock on the ranges of southeastern Arizona have become a serious problem to the cattle industry. For many years cattlemen have seen valuable forage plants being supplanted by less valuable ones such as burroweed, snakeweed, mesquite, cactus, catclaw and others.

The raising of livestock and its accompanying ranching operations make up one of the three most important industries in the State of Arizona; and the range lands in the southeastern corner comprise generally the most valuable grazing lands in the State. By reason of the character of the climate and the forage plants themselves, it is possible to run stock the year-round.

Statistics of the U. S. Bureau of the Census for January 1, 1935, show that in Arizona's five southeastern counties there were 239,100 head of cattle, over one year of age, belonging to 3,789 livestock farms and ranches. In addition, there were 19,580 head of sheep, one year and older.

Some of the most valuable watershed lands in the United States occur in the Southwest, and it is of the utmost importance that land-use management provide for maximum yields of water to storage reservoirs for irrigation.

[1/] Report prepared by Arthur Upson, Director and W. J. Cribbs, Assistant Forest Ecologist, Southwestern Forest and Range Experiment Station, Forest Service, and E. B. Stanley, Animal Husbandman, Agricultural Experiment Station University of Arizona.

power, and public use. But generally speaking, a sparse covering of woody half-shrubs and bushes does not provide the protection to soil or retard rapid surface run-off of rain and melting snow, with consequent protection from erosion, that is provided by a continuous protective covering of grass or grasslike vegetation.

In view of this general situation, it is apparent that any factors which have operated or will operate in the future to reduce the amount of available range grass forage, or which may impair the usefulness of the important watershed lands in Arizona, strike at the very heart of the livestock industry and the social and economic welfare of the people of the state.

It was natural therefore that the question of the spread of unpalatable shrubs on the valuable grazing lands in southeastern Arizona should be raised by stockmen and others; and consequently that the general problem should be considered in connection with agricultural and range conservation and adjustment in the Southwest.

In order to determine the extent of the shrub problem today, its major aspects, and the possibilities of control as a part of the range conservation program under the Soil Conservation and Domestic Allotment Act, a cooperative survey of approximately 12 million acres in southeastern Arizona was organized. The results of this survey, it was expected, would supply factual information on what shrubs now occur on southeastern Arizona ranges; what effect these shrubs have upon the grazing capacity of the grazing lands and upon watershed and other social and economic values; any apparent reasons for the occurrence of the shrubs; whether or not they are spreading and, if so, how fast; what steps might be taken to stop the

spread; and how and where range management, range conservation, and natural or artificial means might be employed as effective controls of the occurrence of these non-palatable plants.

Scope of Work

General supervision of the project was delegated to the Agricultural Experiment Station of the University of Arizona and the Southwestern Forest and Range Experiment Station, of the Forest Service, both at Tucson. These two agencies as well as the Agricultural Adjustment Administration and the Bureau of Agricultural Economics of the U. S. Department of Agriculture provided funds or technical workers[1/] for a period of about three months with which to conduct the field work. The Southwestern Forest and Range Experiment Station analyzed the field data and the four agencies cooperated in the preparation of the final report of which this is a condensed summary.

The field work consisted of (1) an extensive but systematic traversing of nearly 12,000,000 acres; (2) exact measurements of the kind, composition, and density of the present vegetation, particularly shrubs, on over 450 representative sample plots of from 1/10 to 1 acre in area; (3) determination of the approximate limits of plant cover of similar character; (4) general observation on soil types, erosion, and range depletion; and (5) collection of the views of resident stockmen on the past and present condition of the range with respect to forage as well as shrubs of little or no forage value.

[1/] Charles Cochran and Martin Buzan, senior students, University of Arizona; M. J. Culley, Associate Range Examiner, and W. J. Cribbs, Assistant Forest Ecologist, Southwestern Forest and Range Experiment Station

DESCRIPTION OF PRINCIPAL PLANT COVER ON RANGE AREAS

The range areas of southeastern Arizona present wide differences in existing vegetation, varying from those supporting only grasses to those occupied only by shrubs. Between these extremes are all degrees of mixtures of grasses and shrubs. Areas of forest and woodland also occur with practically no shrubs and varying amounts of grasses and other forage. The term "shrubs" is used here in a broad sense to include true shrubs, half-shrubs, brush- or bush-like plants and woody perennial "weeds". The term does not include grass or grass-like plants, miscellaneous herbaceous plants, annual weeds, or trees.

For the purposes of this report, the character of the plant cover throughout the area as a whole may best be presented by dividing the vegetation into nine general types. For convenience each type is designated by the name of the individual plant species, or group of similar plants, found in greatest abundance on a given area. This classification refers solely to the existing vegetation as found in the survey and does not necessarily imply what kind of plants once occupied the area, or that may occupy it in the future.

The location and boundaries of each of the nine vegetation types, as determined in the field work, are shown in figure 1. The boundary of any one type on the map represents the approximate point at which the plant from which the type derives its name ceases to be the most prevalent one. But it should be borne in mind that the characteristic species naturally extends into the adjoining types although in lesser amounts. It is true also that the composition of any one type is extremely variable, and that all but one of the nine areas supports, in addition to the

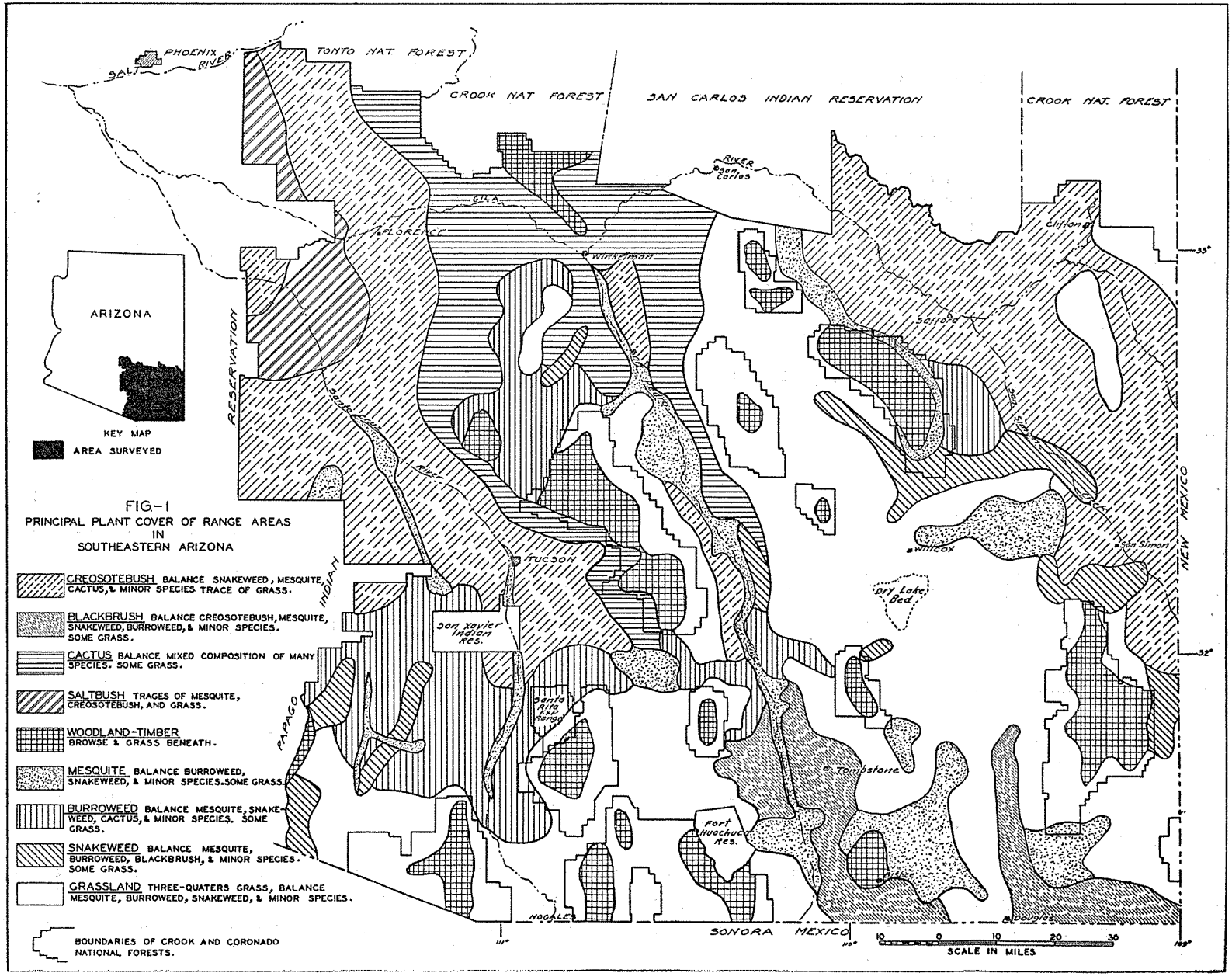
PHOENIX
SALT RIVER
TONTO NAT. FOREST
CROOK NAT. FOREST
SAN CARLOS INDIAN RESERVATION
CROOK NAT. FOREST
RIVER
San Carlos
GILA
FLORENCE
Winkelman
Clifton
Safford
San Simon
Willcox
Dry Lake Bed
NEW MEXICO
33°
32°
RESERVATION
INDIAN
PAPAGO
TUCSON
San Xavier Indian Res.
Santa Rita Range
Tombstone
Fort Huachuca Res.
Bisbee
Douglas
NOGALES
SONORA MEXICO
111°
110°
109°
ARIZONA
KEY MAP
AREA SURVEYED
FIG-1
PRINCIPAL PLANT COVER OF RANGE AREAS IN SOUTHEASTERN ARIZONA
CREOSOTEBUSH BALANCE SNAKEWEED, MESQUITE, CACTUS, & MINOR SPECIES. TRACE OF GRASS.
BLACKBRUSH BALANCE CREOSOTEBUSH, MESQUITE, SNAKEWEED, BURROWEED, & MINOR SPECIES. SOME GRASS.
CACTUS BALANCE MIXED COMPOSITION OF MANY SPECIES. SOME GRASS.
SALTBUSH TRAGES OF MESQUITE, CREOSOTEBUSH, AND GRASS.
WOODLAND-TIMBER BROWSE & GRASS BENEATH.
MESQUITE BALANCE BURROWEED, SNAKEWEED, & MINOR SPECIES. SOME GRASS.
BURROWEED BALANCE MESQUITE, SNAKEWEED, CACTUS, & MINOR SPECIES. SOME GRASS.
SNAKEWEED BALANCE MESQUITE, BURROWEED, BLACKBRUSH, & MINOR SPECIES. SOME GRASS.
GRASSLAND THREE-QUATERS GRASS, BALANCE MESQUITE, BURROWEED, SNAKEWEED, & MINOR SPECIES.
BOUNDARIES OF CROOK AND CORONADO NATIONAL FORESTS.
10 0 10 20 30
SCALE IN MILES

Table 1. - Area, density, and composition of the principal plant cover on ranges in southeastern Arizona

Principal plant cover type	Area		Average density of total vegetation	Principal species making up the plant cover of each type shown in column 1								
	Acres	Percent		Creosote-bush	Blackbrush	Cactus	Saltbush	Burroweed	Snakeweed	Mesquite	Perennial grasses	Other plants
				Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Creosote-bush	3,002,000	24.9	.30	66	0	3	0	0	5	5	0	21
Blackbrush	509,000	4.2	.35	19	29	0	0	3	5	15	4	25
Cactus	1,116,000	9.3	.36	1	0	37	0	3	0	3	5	51
Saltbush	306,000	2.5	.33	2	0	0	97	0	0	1	0	0
Burroweed	1,110,000	9.2	.34	0	0	9	0	52	4	20	5	10
Snakeweed	454,000	3.8	.32	0	2	0	0	10	32	18	11	27
Mesquite	850,000	7.1	.35	0	0	0	0	10	7	59	9	15
Grassland	3,809,000	31.7	.35	0	0	0	0	2	3	9	76	10
Woodland-timber	878,000	7.3		See note								
Total	12,034,000 acres											

Note: In the last nine columns 0 percent means the plant in question was absent or made up less than 1/2 of 1 percent of the vegetation.

The woodland-timber type occurs mostly within the Coronado and Crook National Forests. These areas, having already been covered by Forest Service range surveys, were not covered in the shrub survey. While details as to composition are not given in the above table, the plant cover contains mostly grasses and other plants and only scattering shrubs.

predominant species, one or more of the other shrubs under consideration and also still other miscellaneous plants.

Facts concerning the general make-up of the plant cover of each of these types are given in table 1. In this table perfect vegetation cover is considered as 1,00· and the average composition of each type is expressed in hundredths. Thus 0.35 means that 35/100, or 35 percent, of the ground surface within the type is actually covered by vegetation. In the first column of the table are listed the nine types. Next come the acreage, and percentage of total area, of each type and its average density. Under the heading "Principal species making up the plant cover of each type" are given, in percent of total, the seven different characteristic shrubs, the perennial grasses (grouped as a single item) and "other plants" which make up the vegetation found in each of the nine types given in the first column.

For example, the type designated "Creosotebush" (first column) covers a little over 3,000,000 acres, or about 1/4 (24.9%) of southeastern Arizona, has an average vegetation density of 30 percent, and is actually made up of 66 percent creosotebush, 3 percent of cactus, 5 percent each of snakeweed and mesquite, and 21 percent of other plants of minor importance. Blackbrush, saltbush, burroweed, and perennial grasses are shown as zero percent. There may be traces of these plants but none of the four form as much as 1/2 of 1 percent of the total cover.

The general composition of each of the other types (for woodland-timber see footnote to table) can be determined from table 1. The general appearance of several of the types is illustrated in Plates I to VIII and their location is shown in fig. 1.

Considering all nine types, the average density is 33 percent. The maximum variation between any two types is only 6 percent (30 percent in creosotebush and 36 percent in cactus). This does not mean, however, that there are not limited areas almost bare of vegetation, nor some areas with plant cover of probably 50 to 60 percent density.

RELATION OF SHRUBS TO RANGE CAPACITY AND CONSERVATION

Relative Importance of Types

Numerous factors should be taken into account in any attempt to rate the relative importance of the nine types of plant cover now occupying range areas in Southeastern Arizona.

Of importance to the stock industry and the general public is the maintenance of soil and watershed values afforded by any cover of vegetation. This is distinct and apart from forage production and range values of any type. Generally speaking, timbered and wooded lands with a herbaceous ground cover beneath, and those lands well and uniformly grassed, provide the greatest protection and nutritive values, to existing soil and the greatest aid to the development of new topsoils. In their natural state such lands prevent excessive surface run-off of rain and melted snow, roots open up the soil and aid in deep percolation water, feed perennial springs, and regulate stream flow and water yield. On the other hand, lands only thinly vegetated are poorest in these respects, but better than those bare of vegetation. Thus all the nine types of plant cover found in this survey afford a measure of watershed protection, some more than others, and even though the forage value of some is very low, their present protective cover should not be lessened or destroyed.

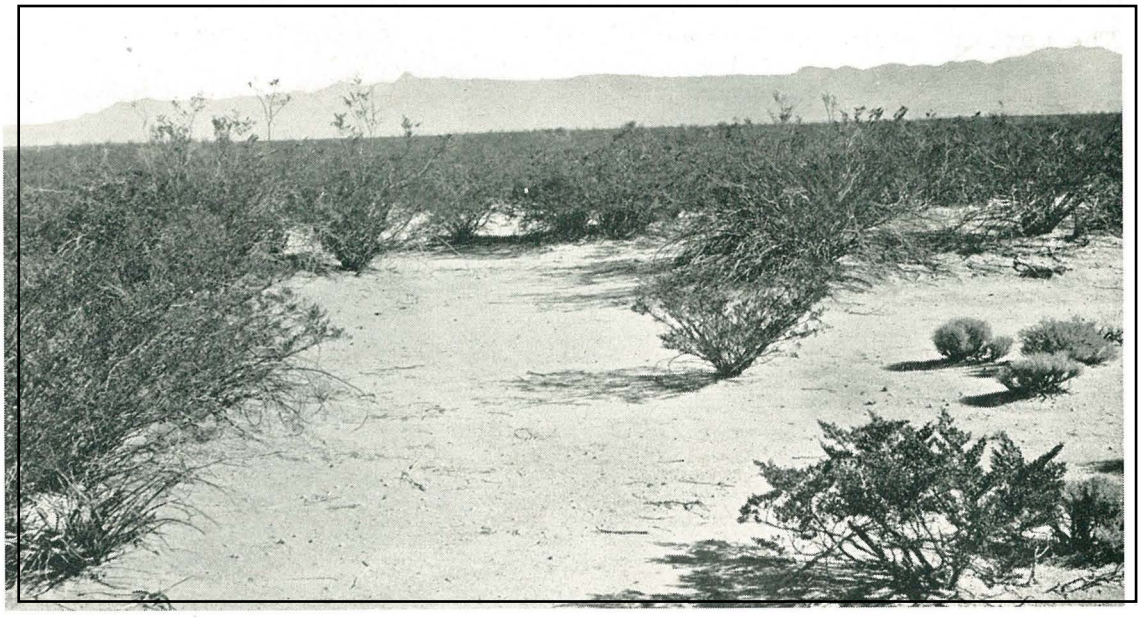

Plate I.—A typical heavy stand of creosote bush on caliche. This area supports no palatable forage plants. San Simon Valley.

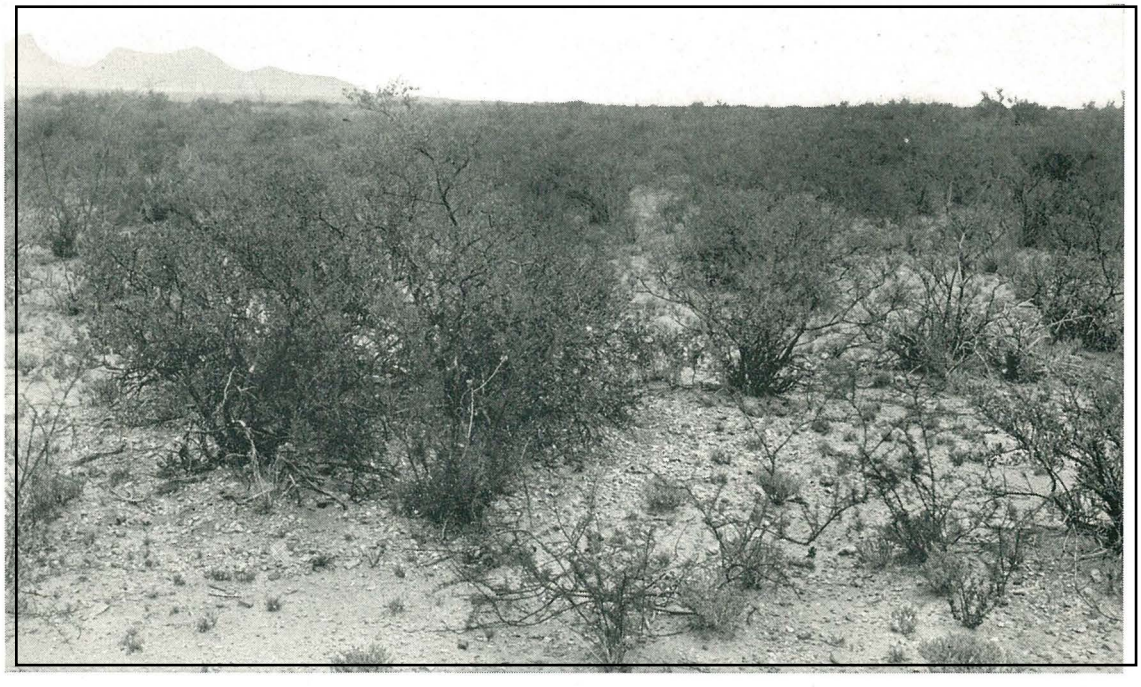

Plate II.—Blackbrush growing on caliche. There are some mesquite, catclaw, acacia, and numerous weeds but only a trace of grass. Upper San Pedro Valley.

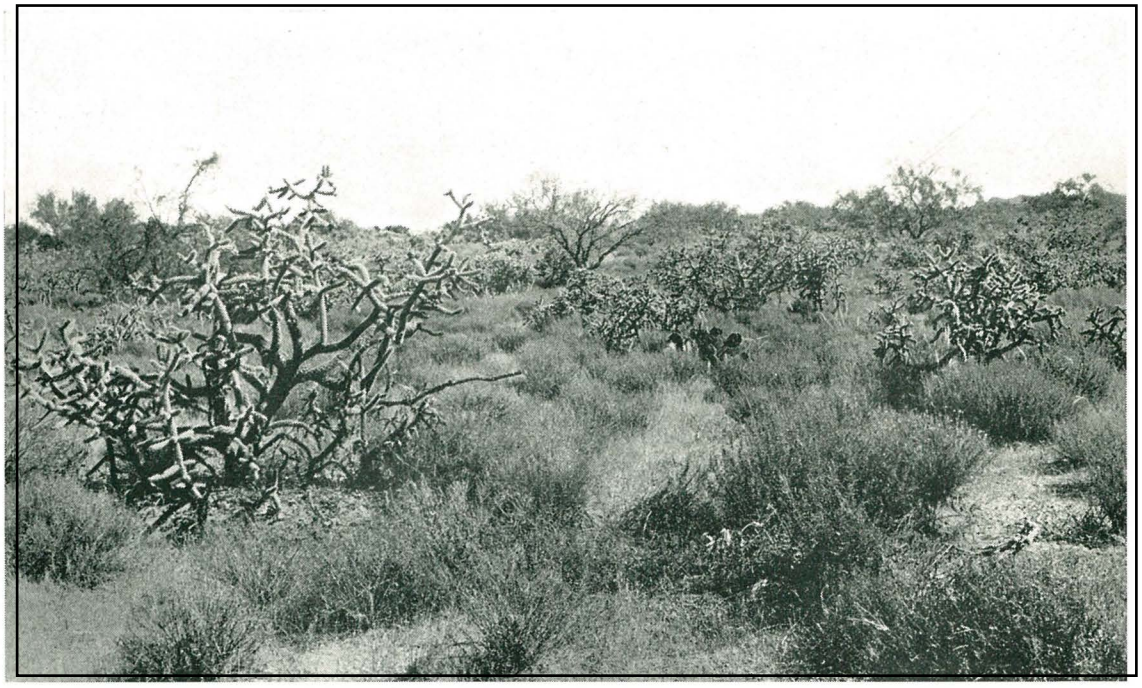

Plate III.—Cactus and burroweed in almost equal stand. Almost all the grass in this view is annual, or six-weeks, grass. Santa Cruz Valley.

Plate IV.—Grassland type. Mixed grama with a very few weeds but with complete absence of shrubs. Sonoita Valley.

Plate V.—Moderately heavy stand of mesquite on mesas of the Santa Cruz Valley. There is more than the average amount of burroweed growing with the mesquite.

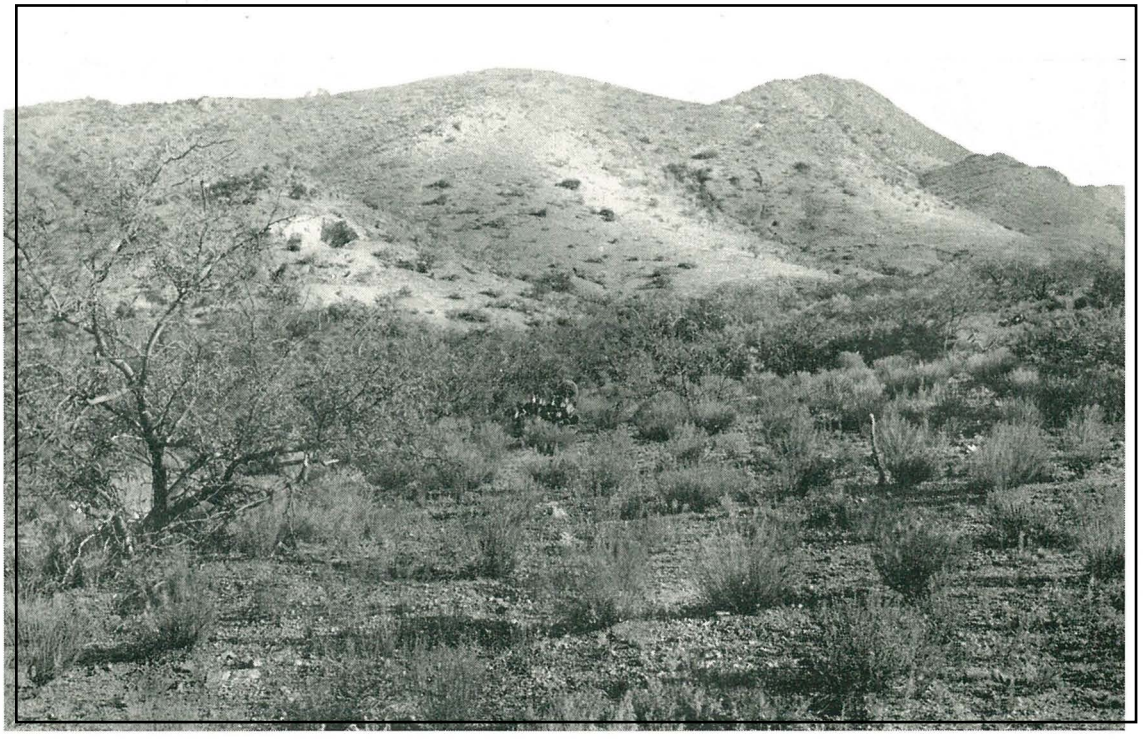

Plate VI.—A snakeweed stand with mesquite, catclaw, hackberry, and numerous annual weeds. A range type of low value. Upper Santa Cruz Valley.

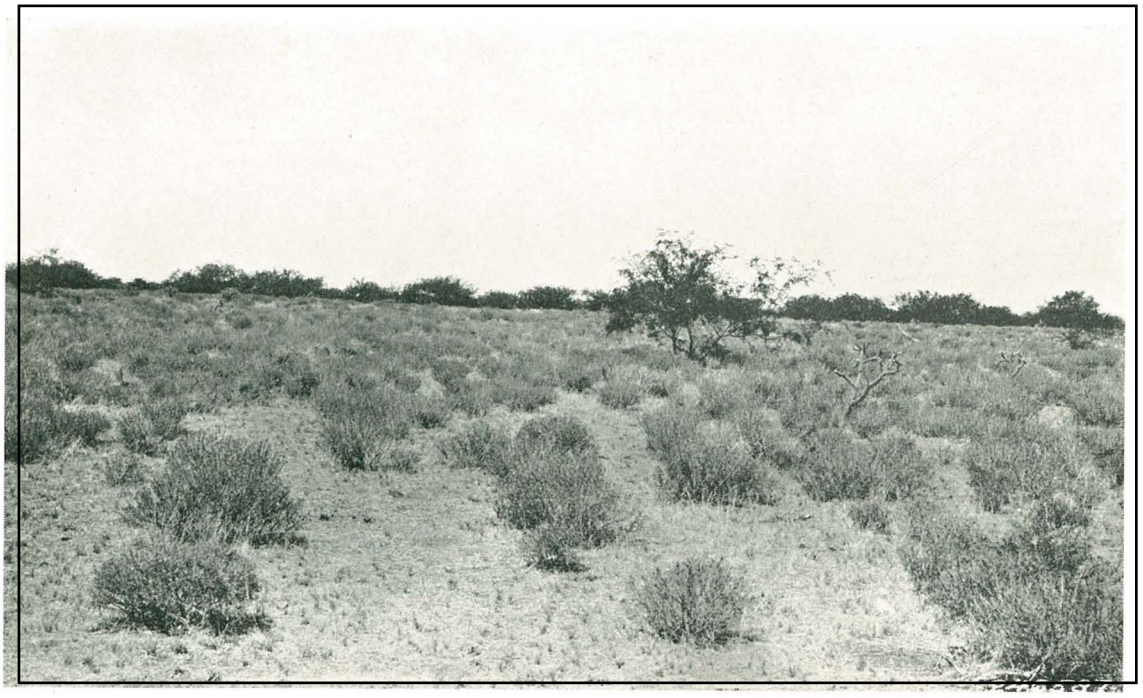

Plate VII.—A typical heavy stand of burroweed with only a small amount of grass. Santa Cruz Valley.

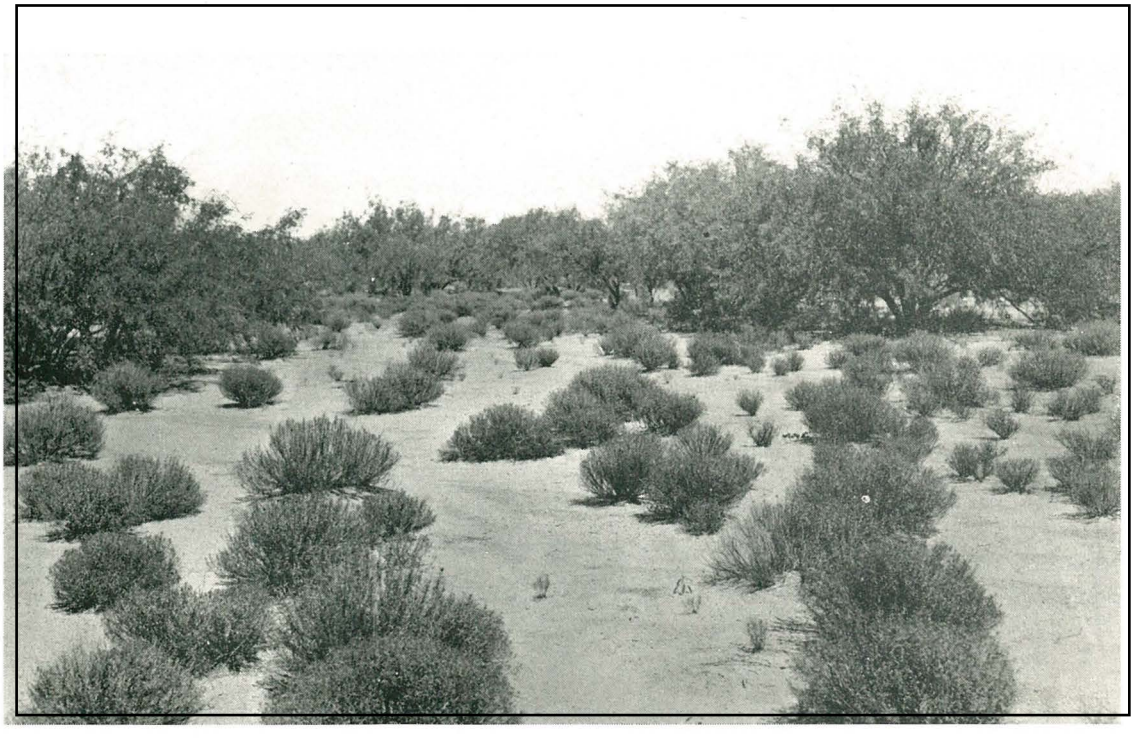

Plate VIII.—A mixed stand of burroweed and mesquite where soil conditions prevent the growth of grass. Santa Cruz Valley.

Factors of importance to the production of maximum yields of forage are palatability to livestock of the vegetation found in each type; its composition from the standpoint of furnishing a variety of forage throughout the year; the density or actual volume of forage available; the acres required to support a cow year long; the area of each type; and the sum total of these factors translated into the economics of livestock production.

With these factors in mind and on the basis of an analysis of the field data, the existing types of plant cover, from the standpoint of their present forage values, and the possibilities of their improvement, may be rated in approximately the following order of relative importance:[1/]

Present Forage Value	Possibilities of Improvement in Forage Value
1. Grassland	1. Grassland
2. Mesquite	2. Burroweed
3. Saltbush	3. Snakeweed
4. Snakeweed	4. Mesquite
5. Cactus	5. Cactus
6. Burroweed	6. Saltbush
7. Blackbrush	7. Blackbrush
8. Creosotebush	8. Creosotebush

[1/] Only 7 percent of the survey area is covered by the woodland-timber type. The timber and woodlands occur mostly within the National Forests and are also important for timber production and watershed values. Through the cooperation of the livestock industry and the Forest Service these lands are now under good range management and are providing and will continue to provide sustained forage production. This type does not, therefore, need methods of range management different from those presently practiced, nor special new treatments in the near

future; hence it is omitted from this classification and further discussion in this report.

From a long-time land-use planning standpoint, most of these eight types might eventually be improved to a point of higher forage production than at present. However, in any such program some types will present a far greater problem than others, from the standpoint of both cost and the order in which they should be considered.

The Problem of Creosotebush and Blackbrush

Among those types that will present the greatest problem, and in which improvement as forage lands will be slow, are creosotebush and blackbrush. Both of these types provide watershed and soil protection values. From the standpoint of forage production, however, they are of low value in their present condition.

Creosotebush and blackbush are probably climax types,[1/] that is most of the areas which they now occupy always supported, naturally, a substantial growth of creosotebush or blackbrush. Further, they occur on the poorer qualities of soil, or on sites with little or no topsoil, or in locations of low rainfall. Success in artificial revegetation would therefore be questionable, even if otherwise desirable.

On the other hand, there is considerable evidence that through improved range management or systems of rotation or deferred grazing some of the perennial grasses which once occurred on these areas might be

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[1/] Atlas of American Agriculture, Part I, Section E, Natural Vegetation by H. L. Shantz and Raphael Zon, Gov't. Printing Office 1924.

brought back. Any range conservation program of the livestock industry and State and Federal agencies should provide for a season of use and stocking of creosotebush and blackbrush lands in accordance with the best obtainable estimate of the actual grazing capacity of the palatable forage plants. Livestock in excess of what palatable plants will provide in feed year after year should not be placed on the range in the thought that they can gain material sustenance from the lowest-value shrubs and weeds. Appreciable dependence on the latter is inevitably accompanied by overuse of the more valuable grasses and other plants.

A pasture of creosotebush lands on the Jornada Experimental Range in New Mexico was slightly improved by protection from grazing for a period of three years, although the actual grazing capacity still remains low.

The Problem of Cactus and Saltbush Types

The present cactus and saltbush types of plant cover in southeastern Arizona provide considerable range feed. The forage value of the saltbush type lies primarily in the palatability to livestock of that species, plus the forage and browse of certain of the accompanying vegetation. The latter plus cactus fruits provide the principal forage. It is not believed that overuse of the range is the principal factor in the spread of cactus.

Perennial grasses at present make up only a small proportion of range forage in these two types. There are some areas where the grazing capacity is as low, or on which it would be just as difficult to increase the forage, as in the creosotebush and blackbrush types. Thus the important feature of any range management plan for the cactus and saltbush

types would likewise be a degree of stocking and seasonal use that will protect and increase the present palatable forage.

Some private ranges of the cactus type which show the results of good range management and a grazing capacity above the average for the type are to be found near Oracle.

Grassland and the Problem of Burroweed, Snakeweed, and Mesquite

The existing grassland areas in southeastern Arizona represent, of course, the climax type. These areas have always supported a stand of perennial grasses mixed with annual grasses and weeds in varying degrees.

There is evidence available that many of the present burroweed, snakeweed, and mesquite lands were in comparatively recent times productive of reasonably good stands of perennial grasses, at least in greater quantity than today. If this be true, then these three types may also be considered, ecologically, a climax grassland type. This, in turn, means that the problem of restoring these three types again to grassland productiveness should offer considerable prospect of success, and far more so than the creosotebush, blackbrush, saltbush, or cactus types.

The Spread of Shrubs

The spread of burroweed and snakeweed to areas where perennial grasses have declined has been going on for decades. There is no evidence, scientific or historical, to indicate that these plants are foreign to the region; in fact they are known to be native since the

coming of the white man. They have always occupied limited waste areas and eroded lands.

Throughout the collection of field data on this survey all opportunities were taken to obtain the personal opinions of local stockmen, especially those who have been resident on the same ranges for a long period of years. There is naturally some divergence of opinion on the extent of the spread of shrubs, but a majority state they have seen burroweed and snakeweed increase manyfold during the past fifty years.

During the early years of the range industry, watering places were not as fully developed as they are today, thus in dry seasons of the year large numbers of cattle concentrated in the neighborhood of permanent water. This led to local overuse, injury to soil and eventually to severe thinning of the perennial grasses. Stockmen state that these particular areas were covered with excellent grass when the range was first put to use. It is probable, therefore, that it was upon many of these areas that the undesirable shrubs got their start and from which they spread to adjoining ranges. Conspicuous examples of this sort of shrub invasion on limited or greater areas occur in the Sierrita Mountains, the foothills of the Santa Rita Mountains, near Oracle, and in the upper Altar Valley. Examples of reduced stands of snakeweed due to the practice of good range management by private owners on their own lands may be found in the Hooker Hot Springs country, the upper San Simon Valley, and in the Sulphur Springs Valley.

In the examination of 450 individual and widely located study plots during the collection of field data the usual situation found was light sheet erosion, a lack of litter or duff on the soil surface, and

grass in the early stages of thinning out, followed by the appearance of burroweed or snakeweed. Thereafter a direct correlation between the deterioration of the soil and vegetation and the increase of the shrubs was evident. Thus an inverse relation exists between grass and burroweed, and grass and snakeweed. This is confirmed in tables 2 and 3.

In any vegetation, long established, the plants best adapted to the existing growth conditions will invariably inhabit the area. Any such change requires long periods of time. During any vegetational change there is always the possibility that changes in growth conditions, including rainfall, are of primary importance. No such periods of time or long-time precipitation changes are involved, however, in the increase of burroweed and snakeweed over the last few decades.

Change in the composition of a vegetation cover, over a short period of time, is therefore probably caused by some change in conditions of growth and inter-vegetation competition. When such changes take place, the existing plants may not be capable of adapting themselves promptly to these new conditions before other plants better adapted can establish themselves. The original vegetation in its normal vigor successfully withstood competition of plants from without. When it became weakened these outside plants were able to take over part of the ground without much competition. Finally the old occupants tend to weaken and die out while other better adapted, more aggressive plants take their place. Further, shrubs which are not palatable to livestock are not continually defoliated. The grasses are. Hence the shrubs are given an advantage in development and reproduction which the grasses are not permitted to have.

Up to the time detailed studies of shrub occurrence in grasslands were initiated several years ago by both the Southwestern Forest and Range Experiment Station and the University of Arizona Agricultural Experiment Station, there were of record little scientific data on the subject. The information then available was based merely on general observations by scientists as well as stockmen, and it showed that the more grass on a given area the less the burroweed or snakeweed, and vice versa. As to why this situation existed or how it came about, there were differences of opinion, some holding that burroweed and snakeweed, for example, are actually crowding out the grass and killing it.

This survey provided opportunities to make numerous additional field observations and to obtain the views of a greater number of stockmen. There is still some difference of opinion but the weight of the information collected to date is in favor of the belief that, for whatever reason, shrubs come in and take the place of the grass after, and not before, the grass has been weakened or killed. This view is confirmed by vegetation changes that often take place following drought years when any combination present of moisture deficiency plus heavy grazing almost always results in grass reduction, followed by an increase of shrubs.

The Problem of Burroweed

Burroweed dominates all other vegetation in slightly less than 10 percent of the total area covered in southeastern Arizona, but in its extreme limits it is found on 45.7 percent (5,494,000 acres) of

the area. In abundance (per acre) it falls in three classes: light stands (0 to 500 plants); medium stands (501 to 1,500 plants); and heavy stands (1,500 plants and over). The acreage covered by each of these three classes and their composition in terms of burroweed, perennial grasses and other plants are given in table 2. The distribution of each class is shown in Figure 2. Here the boundaries are determined solely on the stand of burroweed and the composition of the remaining vegetation is not considered.

Table 2. - Distribution and abundance of burroweeds

Abundance	Number of plants per acre	Area		Composition		
				Burroweed	Perennial grasses	Other plants
	Number	Acres	Percent	Pct.	Percent	Pct.
Heavy	Over 1,500	703,000	5.9	59.2	9.2	31.3
Medium	500-1,500	761,000	6.4	32.0	24.4	43.6
Light	Under 500	4,030,000	33.4	3.4	36.4	60.2
Subtotal		5,494,000	45.7	1/ 14.5	1/ 31.3	1/ 54.2
None		6,540,000	54.3	0	48.5	51.5
Total		12,034,000	- - - -	- - -	- - - - -	- - - - - -

1/ Weighted averages.

Generally speaking, the areas which contain a heavy stand of burroweed are now poor grazing land. Mesquite, which so often is associated with the burroweed, probably produces more forage than the small amount of grass. The perennial grass in heavy burroweed stands is usually in poor condition due to heavy use and the effects of erosion. There appears to be a close correlation between the density of burroweed, the degree of erosion, and the degree of deterioration of soil and vegetation.

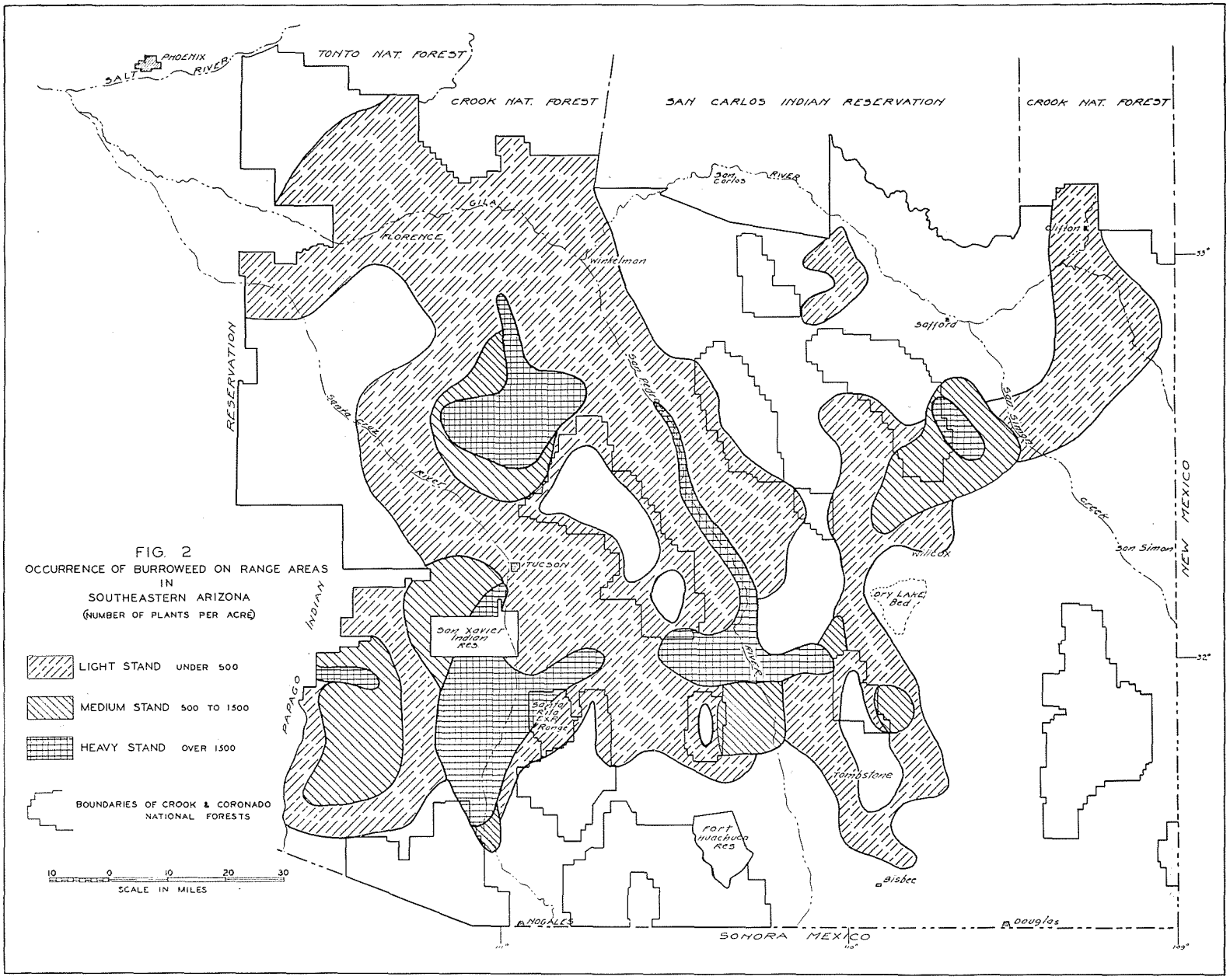


FIG. 2

OCCURRENCE OF BURROWEED ON RANGE AREAS IN SOUTHEASTERN ARIZONA

(NUMBER OF PLANTS PER ACRE)

- LIGHT STAND UNDER 500
- MEDIUM STAND 500 TO 1500
- HEAVY STAND OVER 1500
- BOUNDARIES OF CROOK & CORONADO NATIONAL FORESTS

10 0 10 20 30

SCALE IN MILES

Plate VII shows a heavy stand of burroweed (about 5,000 plants to the acre) with a moderately heavy stand of mesquite on deteriorated sandy soil, a situation fairly typical of the area of heavy burroweed distribution. Such areas will present difficult problems in natural or artificial revegetation.

The areas of medium stands of burroweed (500 to 1,500 plants per acre) are but slightly more extensive than those of the heavy stand. Here there is almost three times as much grass as in the heavy burroweed stands. The light stands of burroweed (less than 500 plants to the acre) are about three times the extent of the heavy and medium areas combined and the percent of perennial grass is a half more than that in the medium stand of burroweed, and nearly four times more than is found in heavy stands.

In general, there is included within the limits of the light burroweed stands, areas that are of a type other than burroweed, principally grassland. Here there is the greatest promise of effective control. Generally speaking, the soil of such areas is in good condition; erosion is not yet a major factor; and there is a sufficient quantity of native grass to furnish seed for natural revegetation of the areas now occupied by burroweed. The potential forage value of such areas is high and expenditures for control are warranted. Where these conditions of soil and perennial grass obtain in the burroweed stands of medium density, control measures should also be feasible.

The Problem of Snakeweed

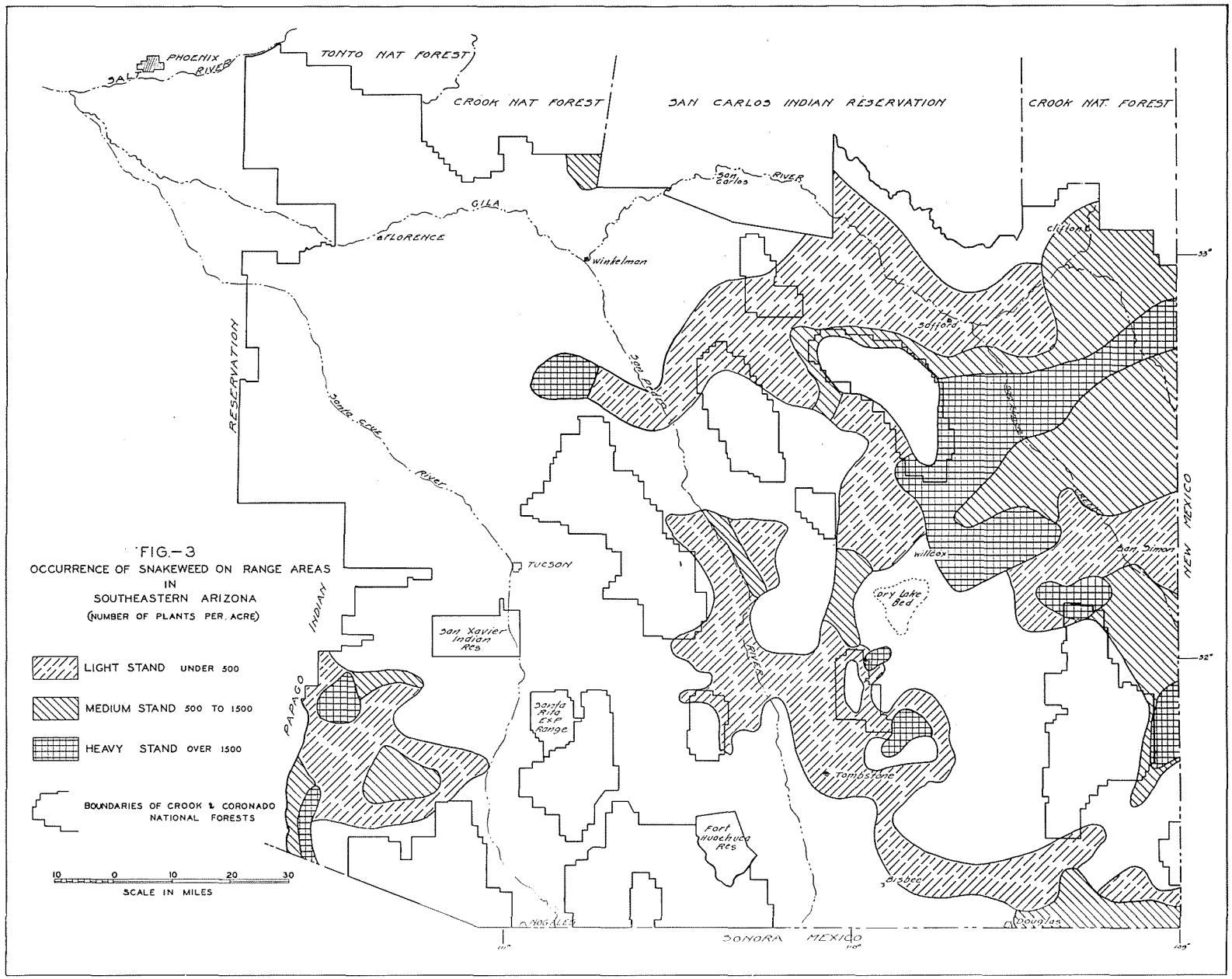
The distribution of snakeweed is more limited than that of burroweed. The total area over which it is found in some degree is about one-third of the total area of the survey (see table 3 and fig. 3).

Table 3. - Distribution and abundance of snakeweed

Abundance	Number of plants per acre	Area		Composition		
				Snakeweed	Perennial grasses	Other plants
	Number	Acres	Percent	Pct.	Percent	Pct.
Heavy	Over 1,500	684,000	5.7	37.8	14.3	47.9
Medium	500 - 1,500	1,202,000	10.0	22.4	21.8	55.8
Light	Under 500	2,152,000	17.9	5.4	43.8	50.8
Subtotal		4,038,000	33.6	1/ 15.9	1/ 32.3	1/ 51.8
None		7,996,000	66.4	0	44.2	55.8
Total		12,034,000	- - -	- - -	- - - - -	- - - - - -

1/ Weighted averages.

The heavy stands of snakeweed cover almost as much area as do the heavy stands of burroweed, but the relation between perennial grass and snakeweed is slightly more favorable. In its heavy stands, the density or abundance of snakeweed is much lower than that of burroweed in its heavy stands. (See tables 2 and 3.) Grass in association with snakeweed run approximately one-half more than with burroweed. Two factors influencing these differences in relation are the smaller average size of the snakeweed plant and the fact that it is found at slightly greater altitude. Undoubtedly there are other undetermined influencing factors.


PHOENIX
SALT RIVER
TONTO NAT FOREST
CROOK NAT FOREST
SAN CARLOS INDIAN RESERVATION
CROOK NAT. FOREST
San Carlos RIVER
GILA
FLORENCE
Winkelman
Clifton
Safford
RESERVATION
Santa Cruz RIVER
TUCSON
INDIAN
San Xavier Indian Res.
PAPAGO
Santa Rita EXP Range
Willcox
Dry lake Bed
San Simon
NEW MEXICO
Tombstone
Fort Huachuca Res
Bisbee
NOGALES
Douglas
SONORA MEXICO
33°
32°
111°
110°
109°
FIG.–3
OCCURRENCE OF SNAKEWEED ON RANGE AREAS IN SOUTHEASTERN ARIZONA
(NUMBER OF PLANTS PER ACRE)
LIGHT STAND UNDER 500
MEDIUM STAND 500 TO 1500
HEAVY STAND OVER 1500
BOUNDARIES OF CROOK & CORONADO NATIONAL FORESTS
10 0 10 20 30
SCALE IN MILES

Medium stands of snakeweed occupy slightly less than double the area occupied by heavy stands. Light stands of snakeweed cover about 18 percent of the area of the survey but only half the area covered by light stands of burroweed. The relation to perennial grass in this area is quite similar to the relation of burroweed in light stands to grass. Here also is an increase in density of grass with a decrease in density of snakeweed.

The progress of the spread of snakeweed appears to be similar to that of burroweed. It first invaded areas around water holes, where the grazing was heaviest; then, as the perennial grass receded, the snakeweed took possession of the area. Also, early appearance is sometimes along highways and railroads.

It was often stated by stockmen that the amount of snakeweed has doubled in some places during the past ten years. North of the Chiricahua Mountains there is an area upon which there is now growing a heavy stand of snakeweed with very little grass. Reliable residents report that hay was cut years ago on parts of this same area. These changes that have occurred in a comparatively small number of years cannot be attributed wholly to the aggressiveness of the shrub itself but to changes in local growth conditions.

Snakeweed, usually, is not as long lived nor as hardy a plant as burroweed. Although it grows in localities of rather low rainfall, it appears to be affected by periods of abnormal drought. To an extent, the plant is susceptible to the attacks of insect larvae, and this parasitism is sometime responsible for a reduction of the stand. It is commonly reported that snakeweed dies out periodically over extensive

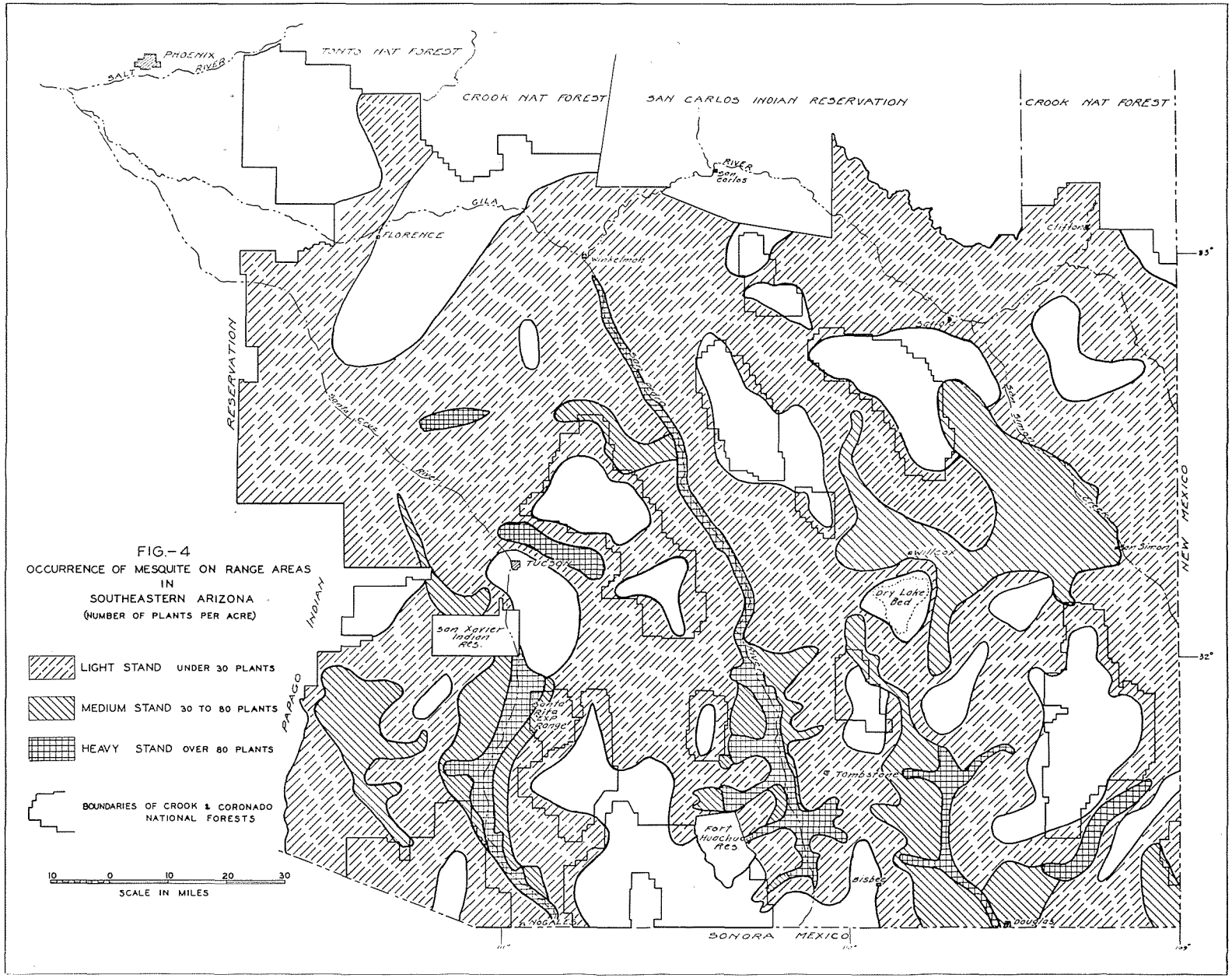
areas, although it usually returns within a few years to replace itself. These characteristics make snakeweed a somewhat less serious menace than burroweed.

Control of the further spread, and perhaps eradication of existing snakeweed in critical areas, when practical methods are known, should also be feasible on areas with soil still in fair to good condition, erosion not yet a factor, and where there is a sufficient quantity of native perennial grass to furnish seed for natural revegetation of the ground surfaces now occupied by snakeweed. Generally speaking, this means those scattered areas of snakeweed growth in the present predominant grass type, the areas in the predominant snakeweed type having snakeweed stands of light density, and possibly the better sites in those areas of medium snakeweed density. But on the badly eroded lands the snakeweed, as also burroweed, should be considered as furnishing some check to more serious erosion.

The Occurrence of Mesquite

In the southeastern part of the State, mesquite is more widely distributed than any other shrub and occurs to some extent in every one of the other eight vegetation types. As a distinct type it occupies but 850,000 acres, most of which are along drainage lines (see fig. 1 and table 1). In lighter stands it is widespread, the total area over which it is found being more than 10 times greater, or 9,187,000 acres (see fig. 4 and table 4).

In general, the relation of perennial grass to mesquite is similar to the relation of grass to other shrubs; the higher the percent of


PHOENIX
SALT RIVER
TONTO NAT FOREST
CROOK NAT FOREST
SAN CARLOS INDIAN RESERVATION
CROOK NAT FOREST
RIVER
San Carlos
GILA
FLORENCE
Winkelman
Clifton
RESERVATION
Gila River
Safford
San Simon
Cr.
Willcox
Dry Lake Bed
NEW MEXICO
INDIAN
Tucson
San Xavier Indian Res.
PAPAGO
Santa Rita Mts.
Range
Tombstone
Fort Huachuca Res.
Bisbee
Douglas
NOGALES
SONORA MEXICO
32°
109°
FIG.-4
OCCURRENCE OF MESQUITE ON RANGE AREAS
IN
SOUTHEASTERN ARIZONA
(NUMBER OF PLANTS PER ACRE)
LIGHT STAND UNDER 30 PLANTS
MEDIUM STAND 30 TO 80 PLANTS
HEAVY STAND OVER 80 PLANTS
BOUNDARIES OF CROOK & CORONADO NATIONAL FORESTS
10 0 10 20 30
SCALE IN MILES

mesquite, the lower the percent of grass. However, somewhat higher ratios of grass to shrubs occur in the heavy and medium abundance classes of mesquite than are found on burroweed and snakeweed areas (see tables 2, 3, and 4). This condition and the value of mesquite as a browse plant accounts for the higher forage value of the mesquite-grass areas.

Table 4. - Distribution and abundance of mesquite

Abundance	Number of plants per acre	Area		Composition		
				Mesquite	Perennial grasses	Other plants
	Number	Acres	Percent	Pct.	Percent	Pct.
Heavy	Over 80	483,000	4.0	64.0	18.0	18.0
Medium	30 - 80	1,347,000	11.2	34.4	29.6	36.0
Light	Under 30	7,357,000	61.1	5.8	40.2	54.0
Subtotal		9,187,000	76.3	1/ 13.0	1/ 37.5	1/ 49.5
None		2,847,000	23.6	0	58.5	41.5
Total		12,034,000	- - - -	- - -	- - - - -	- - - - - -

1/ Weighted averages.

Mesquite has undoubtedly been an occupant of the region since before historic times, and, like other shrubs, has spread during the past fifty years. Unlike burroweed and snakeweed, however, it is not likely that deterioration of soil or thinning of other vegetation are principal factors in bringing about its increase. Mesquite sprouts naturally and may also be aided by cattle scattering the seed over the range. Mesquite has probably always occupied drainage lines and washes, where today it is found in its heaviest stands, and from these

locations it has spread onto mesas and uplands.

Mesquite in some localities is objectionable because of its almost impenetrable growth in valleys, which were formerly sacaton areas or open mesquite stands. Many of these valleys are now so densely covered with mesquite that it is difficult or impossible to work cattle. Control measures should be developed for use where such conditions occur.

STATUS OF SHRUB CONTROL INVESTIGATIONS

Both the University of Arizona Agricultural Experiment Station and the Southwestern Forest and Range Experiment Station of the Forest Service, U. S. Department of Agriculture, over the past several years, have made or now have underway a number of studies of the broad subject of shrubs and weeds.

The Arizona Station has worked mostly on the control of weeds on cultivated lands but has given some study to burroweed. This concerned its ability to withstand drought, its natural enemies in the form of insects and disease, and its possible toxicity. Also, the occurrence and spread of mesquite is being given some attention.

The Southwestern Station has confined its investigations to shrubs and weeds on the range, with the greater attention to practical measures for their control. These investigations cover the control of shrubs both by natural and by artificial means.

Natural Means of Control

The approach to the study of possible means of the natural control of shrubs was based on the general principle of proper land-use,

and the specific principle of good range management. A number of such studies have been conducted over the past 15 years with the following results:

Creosotebush and Blackbrush: The instance cited earlier in this report of the results secured by the protection from grazing of certain creosotebush and blackbrush lands showed that black grama was able to reestablish itself in limited amounts under the shade and protection of the overstory of shrubs; and that upon again opening the area to light stocking the newly set grama plants were able to continue growth and to put out new tufts by stolons although very slowly.

Burroweed: In 1926, an addition from the public domain of several sections of burroweed-covered lands was made to the Santa Rita Experimental Range. At that time perennial grass had practically disappeared. The area was fenced and has since been conservatively grazed. The result is that the density of perennial grasses has increased from about 5 percent to a covering of 15 or 20 percent of the ground surface. These lands are still being grazed by livestock under conservative use and the stand of perennial grasses is slowly but steadily increasing in density.

Snakeweed: On the Jornada Experimental Range in the black grama type in southern New Mexico a series of plots were laid out in 1924, containing perennial grasses and snakeweed in varying proportions, and the vegetation measured each year for 7 years. The plots were closed to grazing from 1925 to 1928 and then lightly utilized the next two years. At the end of the 6th year three plots showed an increase in black grama tuft area of from 4 to 6½ times. On two plots mostly

snakeweed, both grass and snakeweed increased and on one plot there was practically no increase in snakeweed.[1/]

Honey Mesquite: For several years prior to 1928 study was made of the vegetation changes in the honey mesquite sand dune areas of southern New Mexico. Severe use by livestock, along with drought and other natural causes, had previously eliminated practically all of the perennial grasses naturally present in such a type. Closing the small areas to grazing, it was found that the area slowly went through successive vegetation changes which after a period of 3 years brought about a gradual appearance of tufts of the original black grama.[2/]

The instances cited previously in this report of where private range land owners have lightly stocked or in some cases closed to grazing certain of their lands and thereby brought back growth of perennial grasses support these technical findings.

On the other hand, there are a number of fenced plots on two experimental ranges where such favorable results are not readily apparent. When these plots were closed to grazing, neither the areas inside or outside supported much burroweed or snakeweed. After a period of years, one or the other shrub was found inside the protected plots, as well as on the outside grazed lands. All of this may indicate that there are other factors than grazing which favor the spread of shrubs and that those factors should be segregated and studied.

[1/] R. S. Campbell, E. H. Bomberger. The Occurrence of Gutierrezia Sarothrae (snakeweed) on Bouteloua eriopoda (black grama) Ranges in Southern New Mexico. Ecology, Vol. XV, No. 1, January 1934.

[2/] R. S. Campbell. Vegetative Succession in the Prosopis (mesquite) Sand Dunes of Southern New Mexico. Ecology, Vol. X, No. 4, October 1929.

Meanwhile, however, the better evidence points to good range management as a likely, practical means of retarding or preventing the spread of burroweed or snakeweed.

Artificial Means of Control

Studies of this character over the past several years have included experimentation in various artificial means of ridding range areas of shrubs of little or no palatability to livestock. Most of this work has been done on burroweed.[1/] The means tried and preliminary results are as follows:

Grubbing: This means of getting rid of undesirable shrubs has been tried by numerous stockmen. An extensive grubbing project initiated in 1935 by the Forest Service has given results not in complete accord with the results secured by some stockmen. Whereas they report considerable success, with no substantial return of the shrubs after grubbing, the Forest Service studies show that while the burroweed grubbed out is effectively killed, reproduction from seed is abnormally high and that within two years the plots were again occupied by heavy stands of burroweed. It is probable that the cultivation of the soil accompanying the grubbing of the plant prepared an excellent seed bed, and that the handling of the grubbed plants effectively spread the seed. The results to date indicate that before a final appraisal can be made of the method, experimental work should be extended to include grubbing at different times of year so as to catch the dormant, flowering, and seeding periods of the plant. Further study of seed production, its viability, and length of time it can lie dormant on the ground before growing are essential.

1/Studies on a systematic scale were initiated in 1933, and much preliminary constructive information obtained during the next two years by R. R. Humphrey, then Junior Range Examiner, Southwestern Forest and Range Experiment Station, and since January 1, 1936, with the Soil Conservation Service.

Spraying: Small sample areas where the burroweed was sprayed with sulphuric acid showed after two years a slight decreese of mature plants with no noticeable increase in the rate of reproduction.

Blow-torch Burning: Sample plots on which burroweed was burned with a blow torch show a high percent of kill of the weeds with but little injury to grass and no abnormal increase in the number of burroweed seedlings. However, as in the case of spraying, the cost of burning by this method is too high. Further experimentation on equipment and methods might reduce costs within reason.

Broadcast Burning: Some preliminary work has been done upon the removal of burroweed by broadcast burning and so far fairly good results have been obtained from the standpoint of the removal and prevention of reproduction of the plants. Nothing is yet known concerning the effect of the burning on the range grasses or upon the fertility of the soil, its rate of water absorption, or surface-runoff. These are factors just as important as the removal of shrubs themselves and further experimentation should consider them fully before any such method can be recommended.

TENTATIVE CONCLUSIONS ON SHRUB OCCURRENCE AND CONTROL

While time and funds available for this project were limited which, in turn, required that the field work be carried on in an extensive manner, nevertheless it seems possible to draw a number of tentative conclusions and recommendations with respect to shrub occurrence and control on southeastern Arizona ranges.

1. The principal plant cover now existing in southeastern Arizona, on the basis of the dominant or most prevalent individual species, can be

separated into nine different types, namely:

Creosotebush	Grassland
Blackbrush	Mesquite
Cactus	Burroweed
Saltbush	Snakeweed
Woodland-timber	

Mixed with each dominant species is a great variety of more limited amounts of other plants not specifically studied or recorded.

2. Only the grassland type, whose vegetation is made up of 76 percent of perennial grasses, some of the mesquite areas, and most of the woodland-timber type represent good quality range forage lands at the present time. In four of the types perennial grass forms only a small proportion of the plant cover (from 4 to 11 percent), and in two there occurs only traces of grass. The forage value of four types (cactus, saltbush, burroweed, and snakeweed) is only moderate, and of two types (creosote and blackbrush) very low.

3. The rapid spread of burroweed and snakeweed into the present and original grassland type is apparently due to loss of soil and soil fertility, to the thinning out or killing of pre-existing vegetation and to the subsequent changes in growth conditions and vegetation relationships that thus take place. The weight of available information is not to the effect that these shrubs are actively killing out more desirable forage plants. However, further study is justified.

4. From the standpoint of the needs and possibilities of improving their forage value through control of the spread of shrubs by natural or artificial means, the eight types may be rated in approximately the following order.

1. Grassland	5. Cactus
2. Burroweed	6. Saltbush
3. Snakeweed	7. Blackbrush
4. Mesquite	8. Creosotebush

5. Natural means of the control of the spread of shrubs consists of application of good range practices, that is,

(a) Stocking the areas in conformity with the best obtainable estimates of the grazing capacity of the palatable forage plants present in the type, making certain that adequate forage reserve will be left to take care of the estimated numbers of stock during and immediately following years of drought. This reserve on semidesert ranges should be not less than 15 percent, and ordinarily about 20 percent of the average forage produced over a series of years;[1/]

(b) The practice of rotation or deferred grazing on any areas where, after trial, continuous stocking will not permit the re-establishment of perennial grasses; or

(c) If conditions demand, closing the most critical areas to grazing for such period as may be required to bring about improvement in the perennial grass.

6. Artificial means of the control of the spread of shrubs should be tried out, and research upon methods thereof continued, in types and on areas of light and medium shrub occurrence at the present time where soil and forage plants are still in fair condition, namely, grassland, burroweed, snakeweed, and mesquite where considered desirable.

7. In types and on areas where both the original and present vegetation is dominantly unpalatable shrubs, and in those types where the change from the original vegetation has gone so far that little or

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[1/] The amount of this reserve has been determined in technical range studies, the results of which will soon be published.

no grass or soil remain, it is not deemed advisable to attempt artificial control measures no matter how worthless the present plant cover may be as forage.

8. In no case should the removal of unpalatable shrubs be attempted before there is a high degree of certainty that their places will be taken and can be filled by more desirable range forage plants.

CHECK LIST

IMPORTANT GRASSES AND SHRUBS ON RANGE AREAS IN SOUTHEASTERN ARIZONA

Forest Service Common Name	Botanical Name	Other Common Names in Local Use
Burroweed	Aplopappus fruticosus	Rayless goldenrod, Broomweed
Cholla	Opuntia spp.	
Creosotebush	Covillea tridentata	Hediondillo, Blackbrush
Dropseed	Sporobolus spp.	
Grama, black	Bouteloua eriopoda	All individual species often considered merely as "grama grass"
Grama, blue	Bouteloua gracilis	
Grama, crowfoot	Bouteloua rothrockii	
Grama, hairy	Bouteloua hirsuta	
Grama, slender	Bouteloua filiformis	
Grama, sprucetop	Bouteloua chondrosioides	
Jimmyweed	Aplopappus heterophyllus	
Curly mesquite	Hilaria belangeri	Curly mesquite
Mesquite, honey	Prosopis glandulosa	
Mesquite, velvet	Prosopis velutina	
Prickly pear	Opuntia spp.	
Sacaton	Sporobolus spp.	
Sacaton, alkali	Sporobolus airiodes	Saltgrass
Saltbush	Atriplex spp.	Chamiza
Snakeweed	Gutierrezia sarothrae	Broomweed
Tarbush	Flourensia cernua	Blackbrush
Three-awn	Aristida spp.	Needlegrass
Tobosa	Hilaria mutica	Galleta
Wolfberry	Lycium spp.	Blackbrush, Squawbush, (Tomatilla)
	"OTHER PLANTS"	
Acacia	Acacia spp.	Catclaw
Mimosa	Mimosa spp.	Wait-a-bit
	OTHER SHRUBS AND WEEDS	
Eriogonum	Eriogonum spp.	Wild Buckwheat
False-mesquite	Calliandra eriophylla	Guajilla
Hackberry	Celtis spp.	
Jointfir	Ephedra spp.	Canatillo
Jojoba	Simmondsia californica	Coffeeberry
Oak	Quercus spp.	
Ocotillo	Foquieria splendes	
Paloverde	Cercidium spp.	
Ratany	Krameria spp.	
Russian-thistle	Salsola pestifer	
Sacahuista	Nolina microcarpa	Beargrass
Tesota	Olneya tesota	Ironwood
Yucca	Yucca spp.	Soapweed